

## FIRST IN MISSOURI

# BEEF CATTLE FEEDLOT ROLLS OUT ANAEROBIC DIGESTER

*The induced blanket reactor system will process almost half of the 60,000 gallons/day of manure generated.*

Diane Greer



**Hampton Feedlot in Triplett, Missouri, holds around 4,000 beef cattle in 30 open feed pens and four confinement barns with slatted floors built over manure pits.**

**H**AMPTON Feedlot, a custom beef cattle feeding operation in Triplett, Missouri, is turning its waste stream into a revenue stream. The feedlot, started in 1972, is completing construction this month of a \$4 million anaerobic digestion system that will process manure from 2,400 of the feedlot's 4,000 beef cattle. Digesting the manure will improve the operation's waste management practices, reduce energy costs and generate revenues from the sale of renewable energy and fertilizer products.

"We are the first digester for dairy or beef cattle in the state of Missouri and one of the first in the nation on a feedlot," says Terry Smith, a consultant with Missouri Enterprise and acting construction manager on the Hampton project. Typically feedlots hold their cattle in an open dry lot system where it is difficult to collect manure without picking up dirt, rocks and other materials that can be detrimental to digesters. At Hampton Feedlot, cattle are held in 30 open lots and four confinement barns with slatted floors built over manure collection pits.

Currently "clean" manure from the pits is pumped to and stored in a 13-acre lagoon. Waste from the dry lots is collected and piled on land above the la-

goon. Any drainage from the piled manure goes into the lagoon. Lagoon effluent is applied to nearby crops with center pivots and other irrigation equipment. Manure from the dry lots is land applied.

Hampton started investigating the feasibility of anaerobic digestion about four years ago. "We were exploring options to get more value out of our manure as well as reduce the amount we had to use up each year," says Jimmy Daniels, the feedlot's secretary and treasurer. Typically the feedlot produces about 60,000 gallons of waste a day. Installing a digester offered a way to reduce the volume going into the lagoon.

Hampton enlisted Missouri Enterprise (ME), a nonprofit consulting organization, to help with a feasibility study, business plan and permitting. "One of the first steps was linking Hampton Feedlot up with the Missouri Department of Natural Resources (DNR)," explains Jimmy Story, business program manager at ME. "We wanted them to understand that this is going to have a positive impact but also make sure that they looked at the permits needed prior to getting started."

ME's feasibility study initially focused on the market potential of the digester products and the technology options. To better understand the technology and its operation, ME staff

and the Hampton team toured six digester facilities in Wisconsin and Minnesota and conducted numerous telephone interviews with digester operators. A final step analyzed project economics. The study concluded that an anaerobic digester would add value to the business, provide an adequate return on capital invested and improve the environmental stewardship of the feedlot. Hampton's Board of Directors decided to install a digester to process manure collected from the pits beneath the four confinement barns — about half of the manure produced daily by the operation. Remaining manure will continue to be land applied.

Biogas produced by the digester will fuel an engine producing electricity. The power will replace most, if not all, of the electricity purchased from outside sources. Any excess power will be sold. Additional revenues will be earned by drying and bagging the solids for sale as soil amendments.

Digesting half of the facility's waste stream will significantly reduce the nutrient loading in the feedlot's lagoon. Selling the solids will move nutrients out of the local watershed. "It gets it out of the environment, keeps it out of the water and it becomes a useful product," Daniels explains.

The project should also benefit the lagoon, where sediment is starting to form on the sidewalls. "If not as much manure is put into the lagoon, the theory is that it will start revitalizing and cleaning itself up," he adds.

#### DIGESTER SELECTION AND CONFIGURATION

Hampton started construction on the 210,000-gallon digester system, designed by Logan, Utah-based Andigen, LLC, in January 2011. The system is composed of six, 35,000 gallon modified

induced blanket reactors (IBR) operating at temperatures between 100° to 105°F (mesophilic range). "It is a high rate system with a 50 percent volatile solids destruction rate," explains Kevin Pack, vice president of Andigen.

Hampton selected the system because it is modular and expandable. The size of the digester can be readily increased by adding extra tanks if the feedlot decides to capture more waste by doing away with some of their dirt pens and moving to more confinement, Smith explains. Hydraulic retention time is five days or less. "That is another reason we went with Andigen," Daniels says. "Their technology is a lot faster process."

An IBR is patterned after an upflow anaerobic sludge blanket (UASB) reactor but modified to handle higher solids concentrations. The reactor naturally forms a thickened area of sludge ("sludge blanket") in the lower portion of the tank that contains high concentrations of bacteria throughout the tank. Bacteria in this sludge blanket digest the manure, forming biogas. Biogas produced by bacteria in the sludge blanket attaches to the solids, causing the material to float up through the tank. At the top of the tank the material hits a submerged, conical septum that knocks the gas off the solids. The biogas rises through an opening in the center of the septum and exits the top of the tank. The solids tend to sink back down the tank after the gas is knocked off. Effluent also passes through the opening in the septum and exits the tank via a pipe located above the septum. The system does not employ any mechanical or hydraulic mixing, which would flush the bacteria out with the effluent. The net result is more bacteria per cubic foot in the tank.

Hampton expects to feed 26,200 gallons of waste daily to the system. "On feedlots the cows produce a lot less manure because beef cattle are fed differently than dairy cattle," Pack explains. "You have to design and size the system appropriately since you have less total volume of manure per cow. Each feedlot will vary somewhat but at Hampton we found that the cows average about 80



Only manure from beef cattle in the confinement barns (left) will be treated in the reactors. Deep pits with agitators (shown under construction, below) were added at the end of each barn to receive and mix the scraped manure.



lbs/day of manure. This will vary however from 60 to 100-lbs/day depending on the size of the animal and their feeding regimen. On a dairy the milk cows average 147-lbs/day of manure."

Manure will be scraped 3 to 4 times a day into the pits beneath the barns. Deep pits with agitators were added at the end of each barn to receive and mix the scraped manure. "For two of the barns we combined the pits," Smith explains. The combined pit measures 20-ft. by 40-ft. by 8-ft. deep. The storage pits at the other two barns each measure 30-ft. by 12-ft. by 8-ft. deep.

Liquid from the lagoon will hydrate the manure to 7 to 8 percent solids, a consistency that will allow the waste to be pumped to a reception pit, measuring 20-ft. by 30-ft. by 12-ft. deep, at the digester. Two of the barns are located downhill from the digesters. GEA Houle based in Drummondville, Quebec, Canada, designed the system that will pump the manure 1,500 yards and 40-ft. uphill to the reception pit. Agitators in the reception pit homogenize manure from the four barns. The moisture level of the material will be adjusted using lagoon effluent.

Manure is sent from the reception pit to an input pit, measuring 10-ft. by 14-ft. by 12-ft. deep, where any substrates for codigestion will get mixed into the waste. Hampton is planning on codigesting other wastes at a later date.



The induced blanket reactor system is comprised of six digester tanks, each with 35,000-gallon capacity.

"Right now the main focus is to digest the manure."

From the input pit manure is pumped into the bottom of the digester. Along the way the material passes through a heat exchanger, which uses heat captured from the generator to warm the material to 105° to 108°F.

Biogas produced by the digesters will fuel a 300-kW Martin Machinery generator that is expected to produce enough electricity to satisfy on-site electrical needs. Any excess power will be sold to Kansas City Power and Light through Hampton's sister corporation, Hampton Alternative Energy Products (HAEP), under an interconnection agreement. Integration of the on-site power system required a total redesign and reconfiguration of the feedlot's electrical system. Backup power will be provided by the local utility.

Effluent exiting the digesters will flow to a pit and then to a Houle two-roller solids separator. Separated liquids will go into a sparge pit and get recycled back to the digester. "We are looking at other options for what to do with any surplus liquids," Smith says.

HAEP received a Value Added Grant from the Missouri Agriculture and Small Business Development Authority to assess the feasibility of drying and bagging the solids produced by the digester. Missouri Enterprise assisted HAEP with the project and enlisted the services of St. Louis-based Marketing Ideas along with universities and private labs. The upgraded solids were found to be a beneficial fertilizer with a viable market. The final step, a technology assessment to determine the best means to upgrade the product, will be completed shortly.

The process to upgrade the solids will use waste heat from the generator to reduce the moisture level of the solids from 67 to 70 percent to 10 percent or less and kill any remaining pathogens. Hampton expects the generator to produce 22 million BTUs of waste heat during the winter and 45 million BTUs in the summer. "We think we have enough heat," Daniels says. "We are just trying to figure out how to use it efficiently."

## PERMITTING AND FINANCING

Permitting the digester, the first system in Missouri to utilize cattle manure, took over two years. Hampton's nutrient management plan was up for renewal at the same time, which further complicated the process. "It was very challenging as no one really understood what we were trying to accomplish," Daniels says. "But we found all the regulatory agencies and power com-

panies willing to work at getting us through the process. Many of the government agencies worked together to move things forward."

Since the feedlot was already regulated by Missouri DNR as a CAFO (Confined Animal Feeding Operation), the project only needed a water construction permit from DNR's Water Protection Program (WPP). The WPP worked with EPA Region 7 on various issues including the permitting, explains Ming Xu, Energy Specialist, Division of Energy, Missouri DNR. Due to the small size of the engine generator no air permit was required. The project was also subject to a NEPA (National Environmental Policy Act) review. "DNR staff spent quite a bit of time working with both Hampton and U.S. Department of Energy's NEPA review team to obtain a clearance," Xu says.

The project received a \$450,000 grant from the Energize Missouri Renewable Energy Biogas program, run by the DNR Division of Energy and funded by the 2009 American Recovery and Reinvestment Act. USDA Rural Development provided an 80 percent loan guarantee through the Renewable Energy for America Program (REAP). Hampton applied for a Section 1603 Treasury Grant. Issuance of the grant is pending completion of the project. "Grant funding is very important," Daniels says. "Without the subsidies the ROI (return on investment) for the project would not work as well."

Hampton will generate renewable energy and carbon credits. "The credits are not of great value or quantity since we are only producing 300-kWh," he adds.

## ROLE MODEL

Xu wants Hampton to serve as a role model for other CAFOs. "We hope the installation of a digester will prove to Hampton and other feedlots that there is a better way to manage manure from beef production, specifically transitioning from an open lot system to moving the cattle under roof where the manure can be collected."

There are currently 7 beef CAFOs in Missouri. "Over the past few years a number of CAFOs expressed interests in developing digester projects," Xu says. "However, being the first one is always risky both technically and financially. A large number of cattle farms in Missouri have the similar capacity of 4,000 to 5,000 cows. Hampton's success will likely establish a good example and more projects may follow." ■

*Diane Greer is a Contributing Editor to BioCycle.*

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